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Proceedings of the Regional Framework and Assessment of the Scotian Shelf and Southern Grand Banks Atlantic Halibut (*Hippoglossus hippoglossus*) in NAFO Divisions 3NOPs4VWX5Zc

PART I: Framework
November 3-6, 2014
Dartmouth, Nova Scotia

PART II: Assessment
December 8-9, 2014
Dartmouth, Nova Scotia

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and ranges widely in the waters off the east coast of Canada. The management unit (3NOPs4VWX5Zc) is based largely on tagging results that have indicated Atlantic halibut move extensively throughout the Canadian North Atlantic. The last assessment framework for 3NOPs4VWX5Zc Atlantic halibut was completed in 2010. On November 3-6, 2014, a halibut framework assessment (Part I) science advisory meeting was held at Dartmouth, Nova Scotia. A halibut stock assessment (Part II) was held on December 8-9, 2014, also at Dartmouth, Nova Scotia. The overall objective of the framework meeting was to review the data inputs and indices of abundance for 3NOPs4VWX5Zc Atlantic halibut, as well the model(s) used to determine stock status, reference points, risk analysis, and the inter-framework assessment strategy. A 'Halibut Science Workshop' was held in conjunction with the framework meeting. The Statistical Catch at Length (SCAL) model and Operational Model HAL were accepted at the framework meeting, and applied to the subsequent stock assessment of the fishery. The overall objectives of the stock assessment meeting were: review biological and fishery information of the stock; assess model performance; evaluate the current status of the stock relative to the biological reference points developed at the framework meeting; generate forecasting model for purposes of assessing harvest strategies; and report on the bycatch of non-target species in the fishery. Meeting participants felt the Working Papers presented at both the framework and stock assessment meetings provided sound scientific analyses based on the best available information on halibut, and were acceptable for publication as Research Documents pending revision following discussions of the meetings. The Science Advisory Report presented at the stock assessment meeting did not receive complete review prior to meeting adjournment. It was agreed by meeting participants that the science leads and meeting Chair-person would coordinate completion of a draft report consistent with views expressed in the stock assessment meeting on the Working Papers, and circulated as a revised draft Science Advisory Report by email for subsequent review and approval. All comments provided on the circulated report were addressed, and incorporated as necessary, jointly by the science lead and meeting Chair. Sincere efforts were made in the science peer review processes to acknowledge and address all comments and concerns raised by meeting participants provided they were appropriate and within the confines of acceptable peer review practice. The Science Advisory Report received consensus following the stock assessment meeting.

Compte rendu de la réunion sur le cadre et sur l'évaluation du flétan (*Hippoglossus hippoglossus*) du plateau néo-écossais et du sud des Grands Bancs dans les divisions 3NOPs4VWX5Zc de l'Organisation des pêches de l'Atlantique Nord-Ouest

SOMMAIRE

Le flétan de l'Atlantique (*Hippoglossus hippoglossus*), le plus grand des poissons plats, est présent dans toutes les eaux du large de la côte est du Canada. Son unité de gestion (3NOPs4VWX5Zc) a été définie en grande partie d'après les résultats d'opérations de marquage, qui ont révélé que le flétan effectue de vastes migrations dans tout l'Atlantique Nord canadien. Le dernier cadre d'évaluation du flétan des divisions 3NOPs4VWX5Zc a été réalisé en 2010. Du 3 au 6 novembre 2014, une réunion de consultation scientifique sur le cadre d'évaluation du flétan (partie I) a eu lieu à Dartmouth, en Nouvelle-Écosse. Une évaluation du stock de flétan (partie II) a eu lieu les 8 et 9 décembre 2014, à Dartmouth, en Nouvelle-Écosse. L'objectif général de la réunion sur le cadre était d'examiner les données et les indices d'abondance pour le flétan des divisions 3NOPs4VWX5Zc ainsi que les modèles utilisés pour déterminer l'état du stock, les points de référence, l'analyse des risques et la stratégie d'évaluation inter-cadres. Un « atelier scientifique sur le flétan » a eu lieu en même temps que la réunion sur le cadre. Le modèle statistique des prises selon la longueur et le modèle opérationnel (HAL) ont été acceptés pendant la réunion sur le cadre. De plus, ils ont été appliqués à l'évaluation subséquente du stock de la pêche. Objectifs généraux de la réunion sur l'évaluation du stock : examiner les renseignements biologiques et halieutiques sur le stock, évaluer le rendement du modèle, évaluer l'état actuel du stock par rapport aux points de référence biologiques élaborés au cours de la réunion sur le cadre; produire un modèle de prévision aux fins d'évaluation des stratégies de pêche et produire un rapport sur les prises accessoires d'espèces non visées dans la pêche. Les participants à la réunion étaient d'avis que les documents de travail abordés au cours des réunions sur le cadre et sur l'évaluation du stock présentaient des analyses scientifiques éclairées basées sur la meilleure information disponible sur le flétan, et étaient acceptables pour la publication en tant que documents de recherche en attendant la révision à la suite des discussions des réunions. L'avis scientifique présenté au cours de la réunion d'évaluation du stock n'a pas fait l'objet d'un examen complet avant l'ajournement de la réunion. Les participants à la réunion ont convenu que le responsable des sciences et la présidente de la réunion coordonneraient la rédaction d'un rapport préliminaire qui rendrait compte fidèlement des vues exprimées durant la réunion d'évaluation du stock au sujet des documents de travail et que ce rapport serait ensuite distribué par courriel à titre d'ébauche révisée de l'avis scientifique aux fins d'examen ultérieur et d'approbation. Tous les commentaires formulés au sujet du rapport distribué ont été examinés conjointement par le directeur scientifique et la présidente de la réunion et ont été intégrés, au besoin. Des efforts sincères ont été déployés dans le cadre des processus d'examen scientifique par les pairs pour prendre connaissance de tous les commentaires et préoccupations soulevés par les participants et pour en tenir compte, à la condition qu'ils aient été appropriés et dans les limites d'une pratique d'examen par les pairs acceptable. L'avis scientifique a fait l'objet d'un consensus à la suite de la réunion d'évaluation du stock.

PART I: FRAMEWORK

INTRODUCTION

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and ranges widely in the waters off the east coast of Canada. The management unit (3NOPs4VWX5Zc) is based largely on tagging results that have indicated Atlantic halibut move extensively throughout the Canadian North Atlantic. The last assessment framework for 3NOPs4VWX5Zc Atlantic halibut was completed in 2010 (Trzcinski et al. 2011) using a length-based, age-structured catch-at-length model fitted to the total catch, length compositions in the catch, and to the catch rate and length composition of halibut caught in the trawl and longline surveys. The last stock assessment of 3NOPs4VWX5Zc Atlantic halibut was conducted in November 2011 (DFO 2011), during which the 2011 population spawning stock biomass was projected to be above biomass at Maximum Sustainable Yield, or BMSY (i.e. in the healthy zone). The last stock status update was provided in 2014 (DFO 2014), which indicated that the 3NOPs4VWX5Zc Atlantic halibut stock appeared to be increasing despite moderate increases in total allowable catch. Under the current multi-year assessment cycle, the 3NOPs4VWX5Zc Atlantic halibut assessment framework is scheduled for review every 5 years.

On November 3-6, 2014, a halibut framework assessment (Part I) science advisory meeting was held at Dartmouth, Nova Scotia. A halibut stock assessment (Part II) meeting was held on December 8-9, 2014, also at Dartmouth, Nova Scotia. The overall objective of the framework assessment meeting was to review the data inputs and indices of abundance for 3NOPs4VWX5Zc Atlantic halibut, as well the model(s) used to determine stock status, reference points, risk analysis, and the inter-framework assessment strategy. The meeting Chair-person, Dr. Don Bowen, first introduced himself, followed by an introduction of meeting participants (Appendix 1). The Chair thanked meeting participants for attending the DFO Science Advisory Process. The meeting Coordinator provided a brief overview of the Canadian Science Advisory Secretariat (CSAS) science advisory process and the Chair subsequently invited participants to review the meeting Terms of Reference (Appendix 2) and Agenda (Appendix 3). No revisions or additions were made to the Terms of Reference or Agenda. To guide discussion, three Working Papers were provided to meeting participants on October 30-31, 2014, in advance of the meeting date. A 'Halibut Science Workshop' was held in conjunction with the framework assessment meeting. The workshop discussion was not within the scope of the framework assessment meeting Terms of Reference, although its discussion is reported upon in this Proceeding. This Proceeding constitutes a record of both the framework assessment (Part I) and stock assessment (Part II) meeting discussions and conclusions.

PRESENTATION AND DISCUSSION

PRESENTATION OF WORKING PAPERS

Rapporteur: Kristian Curran

The halibut science lead, Dr. Nell den Heyer, led the discussion with support from science co-leads. Presentations centred on three Working Papers presented at the meeting, with the discussion focused on various aspects of the Working Papers, including: stock indices; assessment models; references points and harvest control rules; and a science work plan.

Stock Indices

Presenter: Dr. Nell den Heyer

The management unit for halibut 3NOPs4VWX5Zc was introduced. It was noted that the management unit is large, inclusive of the entire Scotian Shelf and southern Grand Banks. The science lead noted that the biology of the species is well-documented, and that data inputs for assessing the species rely heavily on Industry-DFO collaboration. Overall, the population appears to have increased over the past several years.

Abundance and Catch Composition

Discussion on halibut abundance and catch composition began with some background discussion on the DFO RV trawl surveys. It was noted the survey was not designed for halibut (designed for cod), although it is believed to be an effective survey given juvenile cod and halibut utilize the same habitat. Given low survey catch rates and annual variability, sample sizes in the survey are potentially an important issue at scale up. With respect the Industry-DFO longline halibut survey, it was noted that hook saturation is not measured directly, although crude estimates are possible. Hook size in both the halibut survey and commercial index has increased in some areas, as have catch rates. The science lead noted that for the survey is completed with larger hooks in 3NOPs. It was pointed out that harvesters try to stay away from larger fish given market conditions do not prefer larger fish, with multiple surveys and a standardize survey approach aiming to accommodate a "large fish" bias within the commercial index – not an issue for fixed stations. In general, there is a good relationship between survey design and commercial fishery catch, with the index of abundance designed to accommodate for area effects. That being said, the survey could be refined to include areas where fishing does not occur, in order to determine abundance of fish in areas that are not surveyed (discussed further during the science workshop).

There was a discussion on size composition and lengths. It was indicated that size composition should be applied to landings weighted by subarea. It was noted that some areas in some quarters have less than 2% of landings have observer coverage, with more than 10% observer coverage of landings in the 3NOPs longline fishery. It was asked if catch length composition in 3Ps is independent or influenced by catch in 3NO. The science lead replied that catch at length for the whole management area, weighted by subarea – 3NOPs and 4VWX - is used in the proposed model to produce the catch at-length. It was also asked if a difference exists between 3NO and 3Ps in length versus sex in caught fish, with the science lead indicating that this was not evaluated. The science lead noted it might be possible to tease out seasonality in length versus sex in caught fish in 4Vn, but also noted this would be difficult to do.

It was noted that differences appear in catch composition between the observed longline catch versus port sampling – specifically with respect to larger fish being observed in the catch at sea, relative to the landings that are port sampled. It was further asked if observers accounted for predation mortality (e.g. seals), with the science lead again noted that observers do account for discards, although port sampling does not. Concern was raised regarding the length composition modeled input being too representative of subunit length composition (e.g. 4VW vs. 4VX; 3NO vs. 3Ps). It was noted that the model uses a length composition distribution averaged over all data and that subunits may differ from the overall distribution used in model.

A meeting participant noted that the initial estimate of M from tagging model was to be 0.22, but that M of 0.14 was now being used, thus inquiring why the change. A discussion of the assumptions and uncertainties of the tagging model ensued. It was noted that tagging model assumes a constant natural mortality – the same natural mortality for the time series (2006-2103) and that this natural mortality is in turn assumed as constant for the assessment models

(1970-2013). More accurate estimate of mortality from the tagging model could be achieved if the tag reporting rate was better estimated. A need to publicize the program more broadly beyond Scotia-Fundy and southern Grand Banks regions was reiterated.

There was a brief discussion on potentially increasing the number of core survey stations, with the number of golden stations being increased. It was noted that as the time series continues, more stations have been fished for 4 or more years. Notably, this means that the proportion of stations in the southern (western) reaches of the management unit, relative to the northern (eastern) reaches, has been increasing. It was asked if more stations could be added in a systematic way, and it was noted that adding stations would require more quota.

Growth and Condition (Length-weight)

Most length-weight data comes from Industry commercial catches, with there being a difference in catchability among gears. A meeting participant inquired if 16 size hooks would catch larger fish, and it was noted that this is the case although this has decreased in 3OP – it still might be a factor. The science lead noted that larger hook size in general is only a small component of the overall dataset and that 8-year fish do not exhibit large differences in length-weight throughout the range (Yarmouth to southern Grand Banks). Growth data is a function of survey and commercial data, with the commercial fish being selected from a bank of aged otoliths from observers (with observers only measuring the kept fish). The science lead noted that no additional aging data has been processed since 2007, and this could affect the age-length key (and therefore the model dynamics).

Northern Gulf 4RST Tagging Program

Presenter: Dr. Erin Carruthers

The science lead noted that there is on-going pressure to increase halibut quota in the Gulf of St. Lawrence fishery. The northern Gulf 4RST tagging program aims to fill some gaps in survey data. To date, 700 fish have been double tagged (24 satellite tags), with the majority of tagged fish being cconcentrated in 4R. There is intent to expand the tagging program into a Gulf wide project, with a large role for DFO in coordinating this effort. The present focus of the tagging program is to evaluate how to best get exploitation rates form tagging. From 1994-1999, there was tagging of undersized fish in the Gulf, although the data has not yet been analyzed. Meeting participants agreed that there is a need for some tagging studies on Gulf and coastal halibut stock mixing, as well as further analysis of existing tagging data on stock structure between the two areas. A meeting participant inquired if the Ocean Tracking Network infrastructure could be better used to look at halibut movement between the areas, and the science lead indicated that coded acoustic tags can be picked up by lines maintained by the Network. The tags also can provide retrieve geolocation data (i.e. displacement/movement), and Dalhousie University is currently undertaking a state-space model to work this out in detail. In general, a point was made that tagging efforts should focus on better analyzing existing tagging information before pursuing additional tag deployment.

Bycatch

Presenter: Dr. Daphne Themelis and Dr. Nell den Heyer

The science lead provided an overview of bycatch in the halibut fishery. It was noted that a limitation of accurately quantifying bycatch is the low observer coverage on the Scotian shelf. During the discussion, a participant noted that many halibut get discarded because they are damaged by seals, and this mortality may not be getting accounted for in the assessment models. Other participants noted that in 3NO, by-catch issues have shut down some elements of the fishery in past years. There was a suggestion to compare the observed commercial index

and commercial fishery length composition of halibut to identify discarding (based on sizes caught and recorded in the survey). In addition, it was asked if rather than looking at bycatch species composition by weight if should it be estimated in terms of hook saturation, and it was suggested that this information could be used to evaluate CPUE rates used in the assessment model. The science lead noted that gear saturation is an important question for the CPUE model, but that the data to best address this question (i.e. numbers of fish caught, numbers of hooks without fish or bait) are not available from observer data. The large proportion of wolfish bycatch in the 4X fishery was noted. Last, meeting participants felt the science advisory report should clearly capture the high level of uncertainty that underlies bycatch estimates of the fishery.

The Hague line

Presenter: Dr. Nell den Heyer (for Dr. Nancy Shackell)

There was a presentation on differences in status of halibut in American and Canadian waters proximal to the Hague Line. In the U.S., halibut was assessed as Special Concern in 2004, which is in contrast to halibut abundance in Canadian waters that has improved in recent years (the Canadian fishery is now Marine Stewardship Council eco-certified). The science lead noted that historically halibut was abundant in coastal and offshore waters of the northeastern U.S. In the 1940s, there appears to have been a stock collapse in the U.S., with a question remaining as to what the cause of this may have been. There are cross border surveys and more halibut are consistently caught on the Canadian side. Efforts to map halibut habitat preferences have been undertaken to determine if this may have been a cause of halibut decline in U.S. waters. Results indicated that there still remains an abundance of preferred halibut habitat in the U.S. northeast area. So why are there no halibut in U.S. waters? One participant speculated that halibut as by-catch in the U.S. cod fishery may limit halibut abundance.

Assessment Models

2010 Halibut Assessment Model (VPOP)

Presenter: Mr. Brad Hubley

The accepted model in 2010 was VPOP – broadly described as a length based, age-structured model (see: Trzcinki et al. 2011). The discussion of VPOP centred on its associated size selectivity curve, and that a dome-shaped curve, rather than the model's flat-topped curve, is preferable given areas with very large halibut are avoided by the fishery. Further, the need to reconcile differences between the longline halibut fishery and gillnet halibut fishery were discussed. It was noted that VPOP missed recruits observed in the RV survey in late-1980s to early-1990s. Similarly, it was noted that the VPOP size selectivity curve is by age and not length, as the model is an age-structured model that uses input of mean length-at-age with variability attached to it (natural mortality is sensitive to the age curve). A general discussion on age-length conversion followed, with agreement that age-length conversion moving forward should be improved.

2014 Statistical Catch at Age Model (SCAL)

Presenter: Dr. Sean Cox

An alternate model to VPOP, the Statistical Catch at Age Model (SCAL), was presented for discussion. The general proposal was that SCAL would be used for assessments, with a simpler surplus production model referred to as HAL being used to make decisions in interim years. In terms of SCAL, a single length/age key for commercial catch could be used by NAFO area, as the model might be sensitive to different growth keys. Industry participants made the point that

there are big differences among NAFO areas. Size selectivity was again discussed, with meeting participants noting that size selectivity of the fishery has changed over time as the proportion of longline fishing has increased relative to otter trawl fishing over the past several years, resulting in a predominant dome-topped size selectivity curve for the fishery. The science lead noted that the model could be applied to evaluate the impact of the voluntary release of large fish.

There was a discussion of how the lack of a stock-recruitment relationship in the model would allow FMSY to increase up to FMAX, which is essentially a yield per recruit, with the model exhibiting less advantage of maintaining large spawning stock biomass (SSB). For modeling purposes, constant recruitment (average for the time series) was used rather than Beverton-Holt or Ricker curves. It was noted that 80% of the fishery is juveniles, with the model exhibiting very little retrospective problems. Generally, when a dome-shaped size selectivity curve is incorporated for commercial gear spawning stock biomass increased and reference points changed. Meeting participants suggested the model account for the trawl and longline fishery separately, given the catchabilities are different, as well as a weighted discard mortality to represent different fishing gear. It was generally agreed that there is a need to better represent discard mortality in the model, and allow it to change through time as fishing practices have changed.

It was decided not to use a production model (PMOD) in interim years, as the reference points were not directly comparable to the assessment model (SCAL). Instead, it was decided that the halibut survey index of exploitable biomass and 4VWX RV trawl survey would be used in interim years instead. General agreement regarding SCAL moving forward was to explore different selectivity at age curves to see how they affect total biomass, and to determine if the model is sensitive to this.. One meeting participant noted that looking at selectivity-at-age functions for the length composition from on boat observers versus from sampling at port, would allow one to evaluate accuracy of the discarding parameterization in the model. In addition, there was a request that the influence of voluntary release of large fish be explored in the model. The science lead noted that to improve model fits, length composition should be improved to better reflect observed distributions – especially for males. The science lead concluded that the model is robust to combined sex distributions, becoming less sensitive to sex-based distribution errors when running for model 40-years. Last, it was agreed that the spawning biomass ogive is outdated, and that a more updated ogive is desirable.

It was agreed SCAL would replace VPOP for application in the 2014 assessment of the fishery.

Reference Points and Harvest Control Rules

Presenter: Dr. Nell den Heyer and Dr. Sean Cox

There was a brief presentation on the operating model (HAL) to be used in interim years. The science lead noted that HAL is set up such that the biological reference points and operational reference points can be decoupled; i.e., the biological reference points can be used in the performance testing, but do not have to correspond to the biomass values at which the fishing mortality changes in the harvest control rule. It was further noted that the proposed reference points were set at 0.1 SSB_0. A meeting participant requested clarification of how this was chosen. The science lead explained that the Shaeffer model is symmetrical (not skewed), yielding a limit reference point of 0.2 SSB_0 (or $0.4B_{MSY}$), which the Precautionary Approach (PA) policy suggests as a default would be twice the value of 0.1 SSB_0. It was explained that a skewed production model is more common for groundfish, with 0.1 SSB_0 therefore being more appropriate as a limit reference point.

Science Work Plan

Presenter: Dr. Nell den Heyer

Outcomes of the 2004 science planning workshop for Atlantic halibut were reviewed. The subsequent discussion regarding science work moving forward focused on: tagging, aging, and assessment models.

Tagging

There was discussion on how best to set up a Gulf of St. Lawrence-wide halibut tagging program, which would need to be coordinated through DFO. It was agreed it would be helpful to evaluate how much of the shelf-based stock is leaking outside of the management area (e.g. to U.S., Gulf of St. Lawrence, and north of Grand Banks area). A meeting participant noted that Maine has a lot of tagging information on Atlantic halibut, with much of the tags ending up in Canadian waters. A participant from industry noted that tagging is based on abundance of landings (e.g. CPUE) and not abundance of fish (which remains unknown). It was agreed that using ultrasound to identify sex (and possibly maturity) of tagged fish would be of benefit to the overall tagging program. It was discussed that tagging "whales" returned to the water to get depth recordings could indicate spawning activity. There would not be exact spawning locations, but to some extent that could be inferred from depths. Industry suggested for future research to look at the dynamics of returning small fish versus big fish and how the industry could get the best return. It was noted that for the assessment, the impact of both increasing size at which halibut must be returned to the water, and the impact of returning whales, would be explored.

A meeting participant suggested the tagging information be built into the assessment model, i.e. that the assessment model would be spatially structured, although this was viewed by the science lead as a big jump from where the assessment currently is. Pursuit of additional analyses on differing growth rates between males and females was then discussed. In addition, further work on an estimate of reporting rate for the tagging program is needed for a more reliable estimate of M. A reporting rate of 80% is presently used, although there was suggestion this could be much lower given tags are not always seen on the fish or necessarily returned if they are collected. The use of satellite tags to look at spawning activity was also discussed, and that a better estimate of the selectivity function is needed for the tagging model. In general, it was agreed that moving forward with tagging program priorities should include: 1) determine if there is value in using coded acoustic tags as part of the Ocean Tracking Network (OTN) tagging program; 2) revisit the Halibut survey design to see if more sites need to be added to stocks in under-surveyed NAFO subunits (e.g. 3NOP and 4V vs. 4X); and 3) tagging should continue as a priority research item over the next 5-10 years.

Aging

Aging was viewed as a top research priority moving forward. It was noted that there have not been any otoliths aged in several years, and the growth and maturations rates are suspected to have changed significantly over this time period. In addition, using otolith isotope dating/elemental signatures to look at origins and stock structure, which works well for deep water marine fish, could answer questions regarding halibut movement between areas; perhaps informing how the stock may be seeded as well as spawning areas. A meeting participant noted that a recent ICES 'aging' working group looked at how aging errors could be incorporated into growth models/assessment models, and perhaps science for halibut could look at how aging error could be incorporated into assessment models using generated aging error data to see if improvements could be made. Similarly, the value in aging larger fish should be evaluated given the scatter in ages for these fish. Overall, it was noted that stock-piled otoliths exist that can be aged, and that any aging that is done should select samples in an informed manner to build a

good growth curve, as well as focus on cohorts, rather than years, when selecting otoliths from existing samples.

Assessment Models

It was agreed that discard mortality data is old; thus, sensitivity of the SCAL model to this data should be explored. Further, more pop-up satellite tagging data should be collected if the model is sensitive to this. Meeting participants also agreed that a more formal analysis of size selectivity and growth be pursued; again, noting that maturity-at-age is taken from the literature and is 30-years old (require an updated size-at-age function). Similarly, exploring the utility of incorporating the commercial index into an assessment model would be beneficial, and the science lead noted that a contract is now underway to do this. It was further recommended the halibut survey design be fully assessed to ensure it aligns with requirements of the assessment models – this was viewed as a high priority research item. Improving observer coverage was also a high priority item, given there is a need to more accurately reflect under-reported landings and determine how this might influence M and F. In contrast, it was agreed looking at increased recruitment rate relative to decreased trawler activity is of moderate priority and incorporating ecosystem function into models a low priority item from a stock assessment point of view.

CONCLUSIONS

FISHERY ASSESSMENT

The SCAL model was accepted for application to the stock assessment to be held December 8-9, 2014. It was agreed that there would be a move from the VPOP model to the SCAL model given they are structurally similar, with similar biomass trends and estimates, but that SCAL was easier to operate. The exact configuration of the SCAL model, however, was not agreed on, as there were a few additional sensitivity runs that were requested by meeting participants. In addition, the best-fitting dome-shaped size selectivity curve for the otter trawl fishery had not been determined. Two options for moving forward were suggested. First, change size-selectivity in 1982, the point at which there was a marked change in proportion of gear used in the fishery (from otter trawl to long line). Second, run the model twice with fleet-specific selectivity. This second option was preferred and requested for the assessment meeting. The following, additional criteria and analyses were also agreed to by meeting participants for discussion at subsequent stock assessment:

- Assessment to present a range of model setups, including sensitivity analysis, when presenting findings for consideration at the assessment. This includes looking at sensitivity of model to a range of von-B parameters, with an attempt to separate the longline and other trawl fisheries. That is, test 'flat top' versus 'domed top' during sensitivity analysis.
- Explore diagnostics of SCAL model formulation, as well as modify port sampling data that feeds into the model. It was recommended that at the assessment there be a review of the diagnostics applied to the final configuration (the configuration completed for the framework meeting had been tested for retrospective bias, and performed well with some small adjustments to the model.) Such diagnostics should be repeated for the final model put forward at the stock assessment meeting (i.e. model structure was accepted at the framework meeting, but not the exact configuration).
- There was broad support for using M=0.15 provided sensitivity around it is explored (e.g. M=0.1 and M=0.2) – whales defined as 125 pounds or larger. A final M, however, is to be examined and discussed at the stock assessment meeting. In addition, it was suggested the structure of the port sampled data that feeds into the SCAL model be improved.

- The Science Advisory Report (SAR) should include the historical catch series (the previous SAR's have included this). It was also suggested the SAR provide status relative to specific points (years) in history. The stock is increasing and we are in a period of high recruitment relative to the average from 1970 to 2013.
- Run a range of TAC and a range of F (e.g. 0.15, 0.2, and 0.5) over two generations (over 28 years), with a focus on a five year window given TAC would have to be adjusted every five years. In addition, run harvest strategy scenarios against a baseline scenario, and provide a range of harvest strategies with probabilities of risk of each scenario for management to consider. Last, assume a whale-release survivability of unity, use the longline survey index of biomass to evaluate recruits, and run the model for five years using the RV recruitment index to validate model predictions

There was overall support for use of SCAL in the subsequent stock status assessment and use of HAL to evaluate the impact of harvesting on future stock dynamics, as well as to identify risk of falling below reference points. It was agreed this approach again be reviewed in 5 years.

INTERIM UPDATES

It was recommended that fishery framework and stock assessment meetings occur five years apart with interim assessments every year in between. The interim assessments would be done using the adjusted halibut survey scaled (using a predetermined q) to the SCAL biomass estimates. A chosen F would be applied to SSB from the SCAL model in assessment years and to the scaled halibut index in the interim years. The F would be constant and the TAC would be adjusted annually with a maximum of 15% change, pending discussions on the new simulations and that the simulations indicated performance indicators for such an approach would be met. It was decided that the annual TAC would depend on the SCAL model in assessment years and on the scaled index (3 year mean of the halibut survey – scaled using the q from the SCAL model).

There was discussion about whether the interim TAC's should be based on an index that is weighted to the RV survey as well. It was felt the RV survey is an index largely of pre-recruits and that given the full assessment is every 5 years, by the time a drop in the recruitment is detected in the survey using a 3 year average, and that management has had time to respond to it with a drop in TAC, the next assessment would be imminent. It was decided to use only the halibut survey, which provides an index of fully-recruited halibut for the interim assessment. The RV survey index was seen as having very valuable information on recruits, and should be incorporated in the harvest rules in some way (in addition to being used as input to the SCAL assessment model). It was decided to use a trigger of three years (of the 5 interim years) where the RV survey index falls below average recruitment from 1970 to 2013. Last, it was decided that three years of recruitment falling below average recruitment levels would be considered an exceptional circumstance and a full assessment could be triggered. Also, the maximum increase and decrease of TAC by 15% is to be included in the projection model.

TESTING HARVEST STRATEGIES

It was agreed that HAL would be used to explore/test the outcome of a range in harvest strategies. Scenarios to explore for the assessment included:

- Constant TAC between assessments. It was pointed out that it would be more straight-forward to have a constant F strategy rather than a constant TAC, and there was general agreement. A range in F's should be explored including F=0.1, 0.15, and 0.2. It was agreed in principle, based on the configuration of the model as it was at that time, that F=0.15 would be a reasonable F pending the outcome of the simulations with the new configuration under

the range of scenarios explored. It was decided not to have a ramp on F triggered by biological reference points or by operational reference points, but to prevent avoidable decline early by including the "exceptional circumstance" condition based on pre-recruit levels as described above.

- Projections should run for two generations. The starting point for consideration of F=0.15 was based on natural mortality of M=0.15 from tagging studies (F=0.15 may need to be revised if it does not meet the performance indicators). Further assessment of the harvest strategies would involve HAL runs with M=0.1, 0.15 and 0.2 to see if the procedure is robust to a range in M. The model should also be tested for different steepness parameters for the stock-recruit curve, 0.7, 0.74, and 0.9. The terms of reference included assessing the impact of changing minimum size from 81- 83- and 85-cm.
- Distinction is to be made between the runs that are being asked in preparation for the assessment, and the runs that would be provided to management in the advice - those would be a subset. For the assessment, it was suggested there could be a master table with all runs tested, a dot where performance indicators were met and when they were not met, including indication of which criteria failed. For the runs that worked that would be appropriate to consider, more complete information on the outcomes could be provided in the SAR.

REFERENCE POINTS AND PERFORMANCE CRITERIA

It was noted that this performance measure should not be considered as an objective, and it was agreed that the objective should include growth of the stock to higher levels. A more specific objective or range of possible objectives with timelines and probability are to be defined. A meeting participant suggested that when the requested HAL runs are undertaken the range of objectives that should be met include: biomass at or above Bupper with a 95% probability that the stock increases (positive trajectory) over two generations. When SSB is between Blim and Bupper, limit the probability of decline over the next 10 years from very low (5%) at the limit reference point to moderate (50%) at Bupper; at intermediate stock status levels, define the tolerance by linearly interpolating between these probabilities. Last, the frequency by which SSB is above Blim when rebuilding from below Bupper (50% of the years measured over two generations) should be evaluated.

It was decided that reference points would be used as indicators of stock status, but not be used as triggers for the rules. The limit reference point chosen was the minimum SSB at which there is 50% of the biomass associated with maximum recruitment. This level fell at 2900 tonnes based on the current model configuration, but that level may change somewhat once the model is adjusted based on requested adjustments. It was recognized that this method of establishing the limit reference point has the disadvantage of being highly dependent on maximum recruitment. The situation can occur where maximum recruitment is an outlier and 50% of its value may be higher than recruitment in any other year. It was seen as appropriate for this case given the pattern of stock recruitment data, but a note of caution for applying it in different circumstances without taking the sensitivity to maximum recruitment values into consideration. Other options for limit reference points were considered:

The 0.11 SSB_0 from the SCAL model was considered as an option. The SSB was estimated at 4844 tonnes, which would have put the stock in the critical zone. This reference point indicated a stock status that was seen as contrary to the general sense of the stock being healthy (by science, management, and industry) and at the highest levels seen since the RV survey began in 1970. The SSB_0 levels output by the model have never been observed, and it is uncertain whether the stock was ever in fact that big. Based on estimates of historic catches, the stock was likely much bigger at one time, but it is unknown whether current productivity conditions

would allow for return to such levels again. The principal of a limit reference point being a point at which there is a serious risk of serious or irreversible harm to the resource did not seem to be met by this method. It was therefore decided not to base the limit reference point on SSB_0 from the model.

Although the limit reference point was not based on the potentially very high historic stock sizes, it was agreed that harvest control rule objectives be considered that allow for the stock to potentially grow to these higher levels or at least well beyond current levels (i.e. an objective including a risk neutral target of current levels would likely not take advantage of potential productivity of the stock, at least according to HAL model predictions). Another index considered was SSB associated with the observed breakpoint at which good recruitment was observed for a large number of year-classes - this decreased at 2000 tonnes. This method, a type of quasi-breakpoint rule, was not chosen as it was less objective. It was the lowest of the options (least conservative).

Another index considered was the SSM associated with a 50% probability of producing above average recruitment. One reviewer suggested this option given it fell around 2000 tonnes. In contrast, a science lead suggested 50% of maximum recruitment instead. Because the upper reference point was not based on the model for the same rational as the limit reference point, it was agreed by meeting participants that current (2013) biomass levels as an interim reference point based on an agreed objective would be used, in order to support continued stock growth and to avoid dropping below current levels. There was discussion on the risk tolerance associated with the upper stock reference point. It was noted that a risk neutral performance indicator, as an objective, would allow for a harvest control rule that would keep the stock at current levels. It was agreed to have risk neutral tolerance around the upper stock reference as a performance indicator, but that there would be objectives put forward that included growth above the upper stock reference. Last, a performance indicator requested by industry was to maintain a high stable catch (i.e. low tolerance for a decline in TAC below 2500 tonnes).

PART II: ASSESSMENT

INTRODUCTION

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and ranges widely in the waters off the east coast of Canada. The management unit (3NOPs4VWX5Zc) is based largely on tagging results that have indicated Atlantic halibut move extensively throughout the Canadian North Atlantic. The last assessment framework for 3NOPs4VWX5Zc Atlantic halibut was completed in 2010 (Trzcinski et al. 2011) using a length-based, age-structured catch-at-length model fitted to the total catch, length compositions in the catch, and to the catch rate and length composition of halibut caught in the trawl and longline surveys. The last stock assessment of 3NOPs4VWX5Zc Atlantic halibut was conducted in November 2011 (DFO 2011), during which the 2011 population spawning stock biomass was projected to be above biomass at Maximum Sustainable Yield, or BMSY (i.e. in the healthy zone). The last stock status update was provided in 2014 (DFO 2014), which indicated that the 3NOPs4VWX5Zc Atlantic halibut stock appeared to be increasing despite moderate increases in total allowable catch. Under the current multi-year assessment cycle, the 3NOPs4VWX5Zc Atlantic halibut assessment framework is scheduled for review every 5 years.

On December 8-9, 2014, a halibut stock assessment (Part II) science advisory meeting was held at Dartmouth, Nova Scotia. A halibut framework assessment (Part I) meeting was held on November 3-6, 2014, also at Dartmouth, Nova Scotia. The overall objectives of the stock assessment meeting were:

- Review biological and fishery information on 3NOPs4VWX+5 Atlantic halibut stock. In particular, update the RV survey index of abundance and the halibut survey index of biomass to include 2014.
- Review assessment model performance, including a retrospective analysis and sensitivity of model to assumptions about M and discarding mortality, as well as the biomass and recruitment trends.
- Evaluate the current status of the stock relative to the biological reference points (Blim=minimum biomass that produced 50% of the maximum recruitment, Bupper=highest SSB in 1970-2013 time series) developed at the framework meeting held November 3-6, 2014.
- Generate forecasting advice assuming a range of natural nortalities (M) including the currently estimated M of 0.15. Estimate probability of falling below biological reference points over 2 generations associated with various harvest strategies, including:
  - Fishing mortality (F)=M, where M=0.1, 0.15, and 0.2, while limiting annual changes in the TAC to no more than 15%
  - Constant TAC
  - Voluntary release of live halibut >125 pounds (167 cm)
  - Minimum legal size 83 cm or 85 cm.
- Report on the bycatch of non-target species in the 3NOPs4VWX+5 Atlantic halibut fishery and identify any notable changes in the occurrence of these species relative to previous years.

The meeting Chair-person, Dr. Don Bowen, first introduced himself, followed by an introduction of meeting participants (Appendix 4). The Chair thanked meeting participants for attending the DFO Science Advisory Process. The Chair noted that this was a science peer-review meeting in which a science advisory report would be completed pending acceptance of the Working Papers. The meeting Coordinator provided a brief overview of the Canadian Science Advisory Secretariat (CSAS) science advisory process and the Chair subsequently invited participants to

review the meeting Terms of Reference (Appendix 5) and Agenda (Appendix 6). No revisions or additions were made to the Terms of Reference or Agenda. To guide discussion, three Working Papers were provided to meeting participants on October 30-31, 2014, in advance of the meeting date. A Science Advisory Report was also discussed at the meeting. This Proceeding constitutes a record of both the framework assessment (Part I) and stock assessment (Part II) meeting discussions and conclusions.

PRESENTATION AND DISCUSSION

PRESENTATION OF WORKING PAPERS

Rapporteur: Kristian Curran

Presenter: Nell den Heyer and Sean Cox

The halibut science lead, Dr. Nell den Heyer, reviewed the biology, data inputs, and modeled results in context of proposed guidance provided at the framework meeting held November 3-6, 2015. Co-lead Dr. Sean Cox also provided input into the discussion. The discussion focused various aspects of the Working Papers, including: review of biology and data inputs, modeled outputs, and bycatch. A draft Science Advisory Report was then reviewed at the meeting

Biology and Data Input

The science lead briefly reviewed halibut habitat biology and data input presented at the framework meeting, reminding meeting participants of the highlights and overall discussion of the framework meeting.

Statistical Catch-at-Length (SCAL)

There was a review of the Statistical Catch-at-Length (SCAL) modeled output run based on guidance/agreement provided at the framework meeting. There was discussion on the use of a flat-topped versus dome-shaped size age selectivity curve for longline. Most industry felt the longline curve is a dome-shaped selectivity and not a flat-topped selectivity (flat-topped used in model analysis), this would be exacerbated by discarding of "whales" which at present is illegal. It was noted that the previous figure discussed in November was not disaggregated by gear type, and the figure at that time was dome-shaped. The science lead noted that it is more precautionary to have a flat-topped selectivity curve. The science lead replied that it is difficult to extract a dome-shaped longline size selectivity curve from the data, as data quality is poor. Notably, the flat-topped curve was suggested by reviewers at the framework. It was concluded that sensitivity analysis might help determine if this is an issue or not, and that the difference between the survey curve (flat top) and commercial curve (dome shaped) would help in determining if difference in use of the respective curves in modeled analysis was important or not. It was noted that additional information would be provided throughout the meeting to shed more light on this matter.

The science lead noted that the model now fitted observations better, as the otter trawl and longline data were disaggregated in the model (weighted discard mortality) – disaggregation improved data fitting in the SCAL model. It was asked if variation in proportion-at-length versus length class was calculated, and the science lead indicated this was done and that it was at about the same scale. It was further noted the data demonstrates that dome-shaped selectivity does not provide a good fit given only at-sea observer commercial data was used for NAFO 3, which leads to difficulty in applying a dome-shaped. It was asked if increased observer coverage would result in representative data for use in the model or if it is possible to fit to port-

sampled distributions specifically within the model. The science lead indicated that the latter analysis was possible, although a function conversion would have to be applied.

At the previous framework meeting Blim and Bupper were agreed upon. It was noted that Bupper (2013) should be considered an interim Bupper based on the information available, as the stock appears to be increasing well into the healthy zone. Landings in the 1800's suggest that the stock has been much larger than present and it was suggested that it could continue to grow from current abundance. Meeting participants noted that industry is observing an increase in abundance stock in NAFO 3, and that halibut appears to be wide-spread everywhere (the Laurentian Channel into the Gulf of St. Lawrence up to Quebec). Participants were reminded that the purpose of Bupper is to delineate the cautious and healthy zones in absence of MSY, and that if 1970s data was removed from the model there would be a different interpretation of recruitment.

Operational Model (HAL)

There was a discussion on the operational model HAL. It was noted that harvest strategies were reviewed using a closed loop simulation, as agreed upon at the framework meeting. Meeting participants were reminded that HAL performance indicators are used to judge performance of harvest strategies; they are not used to evaluate a TAC. More specifically, Blim and Bupper are not used to evaluate the TAC. Assuming TAC =2400 tonnes, the fishery exploitation rate is at 14% (F=0.14). Halibut biomass is the highest it has been since 1970. Model output assuming a range of harvest levels and minimum and maximum size limits were assessed. When voluntary release is incorporated into the model, higher rates of depletion in the stock are observed over the long-term. A meeting participant asked why this was the case, and the science lead suggested that it is perhaps because fishing effort becomes concentrated on smaller fish sizes, hence catching a larger number of fish. In contrast, there is not much impact on the stock over the long-term by changing fish size from 81- to 85-cm. A lower F value has lower short-term catch rates, but long-term catch rates are higher.

There was discussion of natural morality and fishery-induced mortality in context of model results. It was asked to what extent different levels of fecundity were reflected in the model. The science lead noted that the only way fecundity enters the model is through SSB – fecundity is not accounted for explicitly in the model. It was further noted that since bigger fish contribute more to SSB, the model assumes fecundity is proportional to weight (that is larger fish are more fecund), although this is not translated in the model given the stock and recruitment ratio is very flat. It was noted that this may be an issue having implications on reference points, and that a key piece of future research should be to investigate the spawning recruitment relationship implied by the SCAL model. It was asked how F relates to M, and the science lead indicated that this relationship was not explored. It was further noted that the models lag behind a few years when looking at natural mortality, as because this is a multi-fleet fishery, it is difficult to define F in HAL – nearly impossible to have a relationship between fishing mortality and yield. It was suggested that perhaps an F between 0.1 and 0.15 is more appropriate to be considered. The science lead again reminded participants of the implications of F at 0.2, in short term catches are higher, in long term biomass declines and catches are lower. Similarly, F=0.15 exhibits higher uncertainty around the median scenario. Perhaps to be more precautionary (e.g. something between F=0.1 and 0.15), you have a lower F over the short term (leading to lower TAC) leaving more fish in the water to support population growth. It was noted that F_{2014} is approximately 0.12, and choosing an F=0.125 is likely close to status quo.

Industry representatives again re-iterated their observation that lots of fish appear to be in the water, so inquired as to why it is being proposed to keep F low and TAC lower to be more precautionary, particularly when the stock appears to be doing well and the market price for

halibut is high. It was agreed that industry would like an increase in TAC, but that there would likely be disagreement within the industry about how much – some want more and some want less. The science lead suggested that narrowing a discussion to F=0.12 and F=0.15 might help lead to a resolution. Industry representatives disagreed with this approach, and that all options should be taken to the Roundtable, with the science advice reflecting the range of options agreed upon at the framework meeting – subsequent analysis is required. It was agreed that the Science Advisory Report (SAR) should include the range of options and identify risks associated with each by including variability about modeled parameters (e.g. Blim, etc.). It was recommended that a table be included in the SAR and Working Paper that includes risk values (e.g. probability below Blim, Bupper, etc.), with a focus on all information from F= 0.1 to F=0.2.

Bycatch

There were no recommendations for improvement of the bycatch analysis made at the framework meeting, so the previously-presented information was again reviewed. It was noted that observer coverage was primarily focused on summer, not throughout the year when fish are caught – there is not consistent observer coverage throughout the fishing season. The analysis looked at types of species being caught as bycatch, including location (e.g. NAFO 3, NAFO 4, etc.), as well as patterns by season (quarterly). In addition, the analysis looked at hook size used per area. The science lead clarified that the 'all skates' category in the analysis included all reported skates plus identified skates. It was recommended that this category be re-organized as "unidentified" skates (similarly for Wolffish), to obtain total bycatch estimates for the fishery. It was also recommended bycatch be organized by tonnage per area.

Interim Years

The meeting Chair-person reminded meeting participants of the procedure for science advice in interim years, as was presented at the framework meeting.

REVIEW OF SCIENCE ADVISORY REPORT

Meeting participants reviewed the SAR section-by-section. It was noted that the meeting Terms of Reference indicated that a range of M values would be assessed, although this analysis was not completed. It was agreed that there was no need to pursue this analysis given that existing analyses support an M=0.15 as an appropriate number – the reason to look at the range of M values was to constrain a correct M. Similarly, stock is extremely productive, so it is counter-intuitive to believe M is high. It was agreed, however, that a modeled run with M=0.14 would be included in the SAR. There was also agreement that a table would be added to the SAR outlining probabilities that the stock would increase over three periods (short, medium, and long-term), including a run at F=0.125. Similarly, plots regarding long term projections under different scenarios (SL=81 cm at F=0.1, 0.14, 0.15, 0.2) were also to be included in the advisory report.

There was discussion of how to describe bycatch species of "special concern" – conservation concern, and whether a figure on observer coverage would be included in the report. Some meeting participants argued that including a figure dedicated to observer coverage was important, and consistent with similar figures included in reports of other fisheries. In contrast, other meeting participants did not see the value in including this figure, feeling that a figure focused on the abundance of bycatch species would be more valuable from a management perspective. As a compromise, it was agreed that text would be added to the report regarding observer coverage spatially and temporarily, with a table being added to the Working Paper in place of the figure. It remains, however, that some meeting participants expressed concern that removing the figure diminished the importance of bycatch/observer coverage in the SAR.

The SAR presented at the meeting did not receive complete review prior to meeting adjournment. It was agreed by meeting participants that the science leads and meeting Chair-person would coordinate completion of a draft report consistent with views expressed in the meeting on the Working Papers, and circulated as a revised draft Science Advisory Report by email for subsequent review and approval. All comments provided on the circulated report were addressed, and incorporated as necessary, jointly by the science lead and meeting Chair-person.

CONCLUSIONS

Meeting participants felt the Working Papers presented at the stock assessment meeting provided sound scientific analyses based on the best available information on halibut, and are acceptable for publication as Research Documents pending revision following discussions of the meeting. The Science Advisory Report presented at the meeting did not receive complete review prior to meeting adjournment. It was agreed by meeting participants that the science leads and meeting Chair-person would coordinate completion of a draft advisory report consistent with views expressed in the meeting on the Working Papers, and circulated as a revised draft Science Advisory Report by email for subsequent review and approval by meeting participants. All comments provided on the circulated report were addressed, and incorporated as necessary, jointly by the science lead and meeting chair. Sincere efforts were made in this science peer review process to acknowledge and address all comments and concerns raised by meeting participants provided they were appropriate and within the confines of acceptable peer review practice. The Science Advisory Report received consensus following the meeting.

REFERENCES CITED

DFO, 2011. Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/001.

DFO. 2014. Stock Status Update of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc).. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/016.

Trzcinski, M.K., S.L. Armsworthy, S. Wilson, R.K. Mohn, and S.E. Campana. 2011. A Framework for the Assessment of the Scotian Shelf and Southern Grand Banks Atlantic Halibut Stock. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/002.

APPENDICES

APPENDIX 1: LIST OF MEETING PARTICIPANTS (PART I: FRAMEWORK)

Name	Affiliation
Adler, David	Ecology Action Centre
Baker-Stevens, Nellie	Eastern Shore Fisherman's Protective Association
Bowen, Don*	DFO Maritimes / Population Ecology Division
Bowlby, Heather*	DFO Maritimes / Population Ecology Division
Cadigan, Noel*	MUN Marine Institute / CFER
Cantafio, Justin*	Ecology Action Centre
Carruthers, Erin*	Fish, Food and Allied Workers
Chapman, Bruce*	Groundfish Enterprise Allocation Council / Atlantic Halibut Council
Claytor, Ross	DFO Maritimes / Population Ecology Division
Coffen-Smout, Scott	DFO Maritimes / Oceans and Coastal Management Division
Courtney, Robert*	North of Smokey-Inverness South Fishermen's Association
Couture, John	Unama'ki Institute of Natural Resources
Cox, Sean*	Contractor
Curran, Kristian*	DFO Maritimes / Centre for Science Advice
Dedrick, Gary	Shelburne Co. Quota Group / Atlantic Halibut Council
Dedrick, Gerry	Shelburne Co. Quota Group
den Heyer, Nell*	DFO Maritimes / Population Ecology Division
Desgagnes, Mathieu*	DFO Quebec / Science IML
Dwyer, Shelley*	Newfoundland & Labrador Department of Fisheries & Aquaculture
Fagan, Robert*	DFO Newfoundland & Labrador / Resource Management
Francis, Cory	Confederacy of Mainland Mi'kmaq
Hubley, Brad*	DFO Maritimes / Population Ecology Division
Jarvis, Harvey*	Fish, Food and Allied Workers
Jayawardane, Aruna*	Maliseet Nation Conservation Council
Kavanaugh, Sana	Confederacy of Mainland Mi'kmaq
Krohn, Martha*	DFO Headquarters / Resource Management
Lambert, Yvan*	DFO Quebec / Science IML
MacDonald, Carl	DFO Maritimes / Resource Management
Mood, Natasha*	Mood Fisheries Ltd.
Newbould, Andrew	DFO Maritimes / Resource Management
Smith, Sean*	DFO Maritimes / Population Ecology Division
Soesbe, Katherine	U.S. National Oceanic and Atmospheric Administration
Swain, Doug*	DFO Gulf / Science
Vascotto, Kris*	Nova Scotia Department of Fisheries & Aquaculture
Themelis, Daphne*	DFO Maritimes / Population Ecology Division
Vigneau, Joel	IFEMER
Wilson, Gabrielle	Atlantic Herring Council
Wilson, Scott	DFO Maritimes / Population Ecology Division

* *Individuals attended entire meeting*

APPENDIX 2: MEETING TERMS OF REFERENCE (PART I: FRAMEWORK)

Assessment Framework for Scotian Shelf and Southern Grand Banks Atlantic Halibut (NAFO Divs. 3NOPs4VWX5Zc)

Regional Peer Review – Maritimes Region

November 3-6, 2014 (Framework)
Dartmouth, Nova Scotia

Chairperson: Don Bowen

TERMS OF REFERENCE

Context

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and ranges widely in the waters off the East Coast. The management unit (3NOPs4VWX5Zc) is based largely on tagging results that indicated Atlantic halibut move extensively throughout the Canadian North Atlantic. The last assessment framework for 3NOPs4VWX5Zc Atlantic halibut was completed in 2010 (Trzcinski et al. 2011) using a length-based, age-structured catch-at-length model fitted to the total catch, length compositions in the catch, and to the catch rate and length composition of halibut caught in the trawl and longline surveys. The last assessment of 3NOPs4VWX5Zc Atlantic halibut was conducted in November 2011 (DFO 2012), during which the 2011 population spawning stock biomass was projected to be above B_{MSY} (i.e., in the healthy zone). A stock status update was provided in 2014 (DFO 2014), which indicated that the 3NOPs4VWX5Zc Atlantic halibut stock appeared to be increasing despite moderate increases in total allowable catch.

Under the current multi-year assessment cycle, the 3NOPs4VWX5Zc Atlantic halibut assessment framework is scheduled for review every 5 years.

Objectives

The objective of this meeting is to review the data inputs and indices of abundance for 3NOPS4VWX+5 Atlantic Halibut, as well the model(s) used to determine stock status, reference points, risk analysis and the inter-framework assessment strategy. Specifically,

Review of Fishery Data Inputs and Indices of Abundance:

- Review fishery data inputs including spatial and temporal distribution, size and age composition.
- Review estimates of natural and fishing mortality from multiyear mark-recapture analysis of tagging.
- Review indices of abundance, including halibut survey fixed station and commercial index catch rates, and all relevant research vessel surveys (Scotian Shelf and Newfoundland).

Assessment of Model(s) to Monitor Stock Status and Productivity:

- Determine the methodology to estimate the current status of the stock, including methods for estimating stock size and fishing mortality.
- Determine the methodology to characterize stock productivity including reference points for fishing mortality and spawning stock biomass.
- Determine forecasting methodology for providing advice on a range of harvest levels associated with various F strategies, including Fref, along with the probability risk of falling below biological reference points over the longer term 15-20 years while limiting annual changes in the TAC to no more than 15%.

- Determine the methodology to estimate the impact on yield of alternative management actions, including:
  - Voluntary release of live halibut >125 pounds or 170 cm.
  - Determine the minimum legal size that would produce maximum yield:
    - Evaluate the impact on yield of moving from the current minimum legal size of 81 cm to a new value (e.g., 83cm or 85cm.)
    - Evaluate the impact on yield of moving in a single step or incrementally in [2] cm steps over a short period, (consecutive years or with a one year lag).

Evaluation of Ecosystem Information:

- Describe and review the methodology used to estimate incidental catch of non-target species in the Atlantic halibut fishery.

Establish Annual Review Process and Science Workplan

- Provide guidance on inter-framework review activities, including the procedure and frequency of providing fisheries management advice and events that would trigger an earlier-than-scheduled assessment.
- Review research program and, based on the assessment needs, develop 5-10 year research priorities.

Expected Publications

- Proceedings
- Research Document(s)

Participation

- Fisheries and Oceans Canada (DFO), Science, Resource Management, Ecosystem Management, and Policy sectors
- Province of Nova Scotia
- Academics
- Aboriginal communities/organizations
- Fishing Industry
- Other invited experts

References

Trzcinski, M.K., S.L. Armsworthy, S. Wilson, R.K. Mohn, and S.E. Campana. 2011. A Framework for the Assessment of the Scotian Shelf and Southern Grand Banks Atlantic Halibut Stock. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/002.

DFO, 2011. Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/001.

DFO. 2014. Stock Status Update of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc).. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/016.

APPENDIX 3: MEETING AGENDA (PART I: FRAMEWORK)

Assessment Framework for Scotian Shelf and Southern Grand Banks Atlantic Halibut (NAFO Divs. 3NOPs4VWX5Zc)

Regional Peer Review – Maritimes Region

November 3-6, 2014 (Framework)
Class of '47 Boardroom, Marine House
Dartmouth, Nova Scotia

Chairperson: Don Bowen

DRAFT AGENDA

Review of the Atlantic Halibut Assessment Framework

November 3, 2014 - Monday

9:00 - 9:15	Introductions and Review of Agenda
9:15 – 10:30	Biology, Landings, and Abundance Indices (Nell den Heyer)
10:30 – 10:45	BREAK
10:45 - 12:00	Catch Composition (Nell den Heyer)
12:00 - 1:00	Lunch (not provided)
1:00 - 2:30	Bycatch (Daphne Themelis)
2:30 – 2:45	BREAK
2:45 – 4:30	2009 Accepted Catch-at-Length Assessment Model (VPOP) Update (Brad Hubley)

November 4, 2014 - Tuesday

9:00 - 9:15	Review of Previous Day
9:15 - 10:30	Statistical Catch-at-Length (SCAL) Model (Sean Cox)
10:30 - 10:45	BREAK
10:45 – 12:00	Statistical Catch-at-Length (SCAL) Model continued (Sean Cox)
12:00 - 1:00	LUNCH (not provided)
1:00 – 4:30	State-Space Production (PMOD) Model (Sean Cox)

November 5, 2014 - Wednesday

9:00 – 9:15	Review of Previous Day
9:15 – 10:30	A Multi-fleet Length-based Model (HAL) (Sean Cox)
10:30 – 10:45	BREAK
10:45 – 12:00	Discussion
12:00 – 1:00	LUNCH (not provided)

Review of Atlantic Halibut Research Program

1:00 – 1:15	Introduction to Halibut Research Program (Nell Den Heyer)
1:15 – 1:30	The 2014 Atlantic Halibut Tagging Program in the Northern Gulf of St. Lawrence (Erin Carruthers)
1:30 – 1:45	Ageing, Growth and Longevity of Atlantic Halibut off Nova Scotia and Newfoundland (Steve Campana)
1:45 – 2:00	Satellite Tagging of Atlantic Halibut Reveals Movements and Spawning (Steve Campana)
2:00 – 2:15	PSAT Tagging for Tagging Mortality and Habitat Use (Sean Smith)
2:15 – 3:15	Halibut-All-Sizes Tagging: Multi-year Mark Recapture, Movement and Distribution (Nell den Heyer)
3:15 – 3:30	BREAK
3:30 – 4:00	Halibut and The Hague Line (Nancy Shackell, presented by Nell den Heyer)
4:00 – 4:30	Discussion on Knowledge Gaps, Needs and Research Requirements

November 6, 2014 - Thursday

9:00 - 9:15	Review of Previous Day
9:15 - 10:30	Discussion on Knowledge Gaps, Needs and Research Requirements
10:30 - 10:45	BREAK
10:45 – 12:30	Prioritization of Research Activities

Working Papers

Data Review and Assessment Model Update: 2014 Framework Review of the Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc).

Bycatch of non-targeted species in the Scotian Shelf and Southern Grand Banks (NAFO 3NOPs4VWX5Z) Atlantic Halibut Longline Fishery.

Scotian Shelf and Southern Grand Banks (NAFO 3NOPs4VWX5Z) Atlantic Halibut 2014 Framework Models: Statistical Catch-at-Length (SCAL), State-Space Production (PMOD) Model (Sean Cox), and a Multi-fleet Length-based Model (HAL) for forecasting.

APPENDIX 4: LIST OF MEETING PARTICIPANTS (PART II: ASSESSMENT)

Name	Affiliation
Baker-Stevens, Nellie	Eastern Shore Fisherman's Protective Association
Baker, Lori	Eastern Shore Fisherman's Protective Association
Bowen, Don*	DFO Maritimes / Population Ecology Division
Bowlby, Heather*	DFO Maritimes / Population Ecology Division
Cantafio, Justin*	Ecology Action Centre
Chapman, Bruce*	Groundfish Enterprise Allocation Council / Atlantic Halibut Council
Coffin, David*	DFO Newfoundland & Labrador / Resource Management
Courtenay, Robert	North of Smokey-Inverness South Fishermen's Association
Couture, John	Unama'ki Institute of Natural Resources
Cox, Sean*	Contractor
Curran, Kristian*	DFO Maritimes / Centre for Science Advice
Dedrick, Gary*	Shelburne Co. Quota Group / Atlantic Halibut Council
den Heyer, Nell*	DFO Maritimes / Population Ecology Division
Desgagnes, Mathieu	DFO Quebec / Science IML
Dwyer, Shelley*	Newfoundland & Labrador Department of Fisheries & Aquaculture
Grant, Catherine*	Ecology Action Centre
Hart, Dvora	U.S. National Oceanic and Atmospheric Administration
Hennen, Daniel	U.S. National Oceanic and Atmospheric Administration
Hubley, Brad*	DFO Maritimes / Population Ecology Division
Jarvis, Harvey*	Fish, Food and Allied Workers
Kavanaugh, Sana*	Confederacy of Mainland Mi'kmaq
Krohn, Martha*	DFO Headquarters / Resource Management
MacDonald, Carl*	DFO Maritimes / Resource Management
McNeely, Joshua	Maritime Aboriginal Peoples Council / IKANAWTIKET
Mood, Natasha*	Mood Fisheries Ltd.
Newbould, Andrew	DFO Maritimes / Resource Management
Smith, Sean*	DFO Maritimes / Population Ecology Division
Soesbe, Katherine	U.S. National Oceanic and Atmospheric Administration
Swain, Doug*	DFO Gulf / Science
Themelis, Daphne*	DFO Maritimes / Population Ecology Division
Vascotto, Kris*	Nova Scotia Department of Fisheries & Aquaculture
Wilson, Gabrielle	Atlantic Herring Council
Wilson, Scott	DFO Maritimes / Population Ecology Division

* *Individuals attended entire meeting*

APPENDIX 5: MEETING TERMS OF REFERENCE (PART II: ASSESSMENT)

Assessment Framework for Scotian Shelf and Southern Grand Banks Atlantic Halibut (Div. 3NOPs4VWX5Zc)

Regional Peer Review – Maritimes Region

December 8-9, 2014 (Assessment)
Dartmouth, Nova Scotia

Chairperson: Don Bowen

TERMS OF REFERENCE

Context

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and ranges widely in the waters off the East Coast. The management unit (3NOPs4VWX5Zc) is based largely on tagging results that indicated Atlantic halibut move extensively throughout the Canadian North Atlantic. The last assessment framework for 3NOPs4VWX5Zc Atlantic halibut was held November 3-6, 2014, using a length-based, age-structured catch-at-length model fitted to the total catch, length compositions in the catch, and to the catch rate and length composition of halibut caught in the trawl and longline surveys. The last assessment of 3NOPs4VWX5Zc Atlantic halibut was conducted in November 2011 (DFO 2011), during which the 2011 population spawning stock biomass (SSB) was projected to be above B_{MSY} (i.e., in the healthy zone). A stock status update was provided in 2014 (DFO 2014), which indicated that the 3NOPs4VWX5Zc Atlantic halibut stock appeared to be increasing despite moderate increases in total allowable catch (TAC).

Under the current multi-year assessment cycle, the 3NOPs4VWX5Zc Atlantic halibut assessment is scheduled every 5 years.

Objectives

The objectives for this science advisory assessment meeting are:

- Review biological and fishery information on 3NOPs4VWX+5 Atlantic Halibut stock. In particular, update the RV survey index of abundance and the halibut survey index of biomass to include 2014.
- Review the assessment model performance, including a retrospective analysis and sensitivity of model to assumptions about M and discarding mortality, and the biomass and recruitment trends.
- Evaluate the current status of the stock relative to the biological reference points (Blim=minimum biomass that produced 50% of the maximum recruitment, Bupper=highest SSB in 1970-2013 time series) developed at the framework meeting held November 3-6, 2014.
- Generate forecasting advice assuming a range of Natural Mortalities (M) including the currently estimated M of 0.15. Estimate probability of falling below biological reference points over 2 generations associated with various harvest strategies, including:
  - Fishing mortality (F)=M, where M=0.1, 0.15, and 0.2, while limiting annual changes in the TAC to no more than 15%
  - Constant TAC
  - Voluntary release of live halibut >125 pounds (167 cm)
  - Minimum legal size 83 cm or 85 cm.

- Report on the bycatch of non-target species in the 3NOPs4VWX+5 Atlantic Halibut fishery and identify any notable changes in the occurrence of these species relative to previous years.

Expected Publications

- CSAS Science Advisory Report
- CSAS Proceedings
- CSAS Research Document(s)

Participation

- Fisheries and Oceans Canada (DFO), Science, Resource Management, Ecosystem Management, and Policy & Economics sectors
- Province of Nova Scotia and Province of New Brunswick
- International (France and U.S. NOAA)
- Academics
- Aboriginal communities/organizations
- Fishing Industry
- Other invited experts

References

DFO, 2011. Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/001.

DFO. 2014. Stock Status Update of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/016.

APPENDIX 6: MEETING AGENDA (PART II: ASSESSMENT)

Assessment Framework for Scotian Shelf and Southern Grand Banks Atlantic Halibut (NAFO Divs. 3NOPs4VWX5Zc)

Regional Peer Review – Maritimes Region

December 8-9, 2014 (Assessment)
King Boardroom, BIO
Dartmouth, Nova Scotia

Chairperson: Don Bowen

DRAFT AGENDA

8 December 8 – Monday

9:00 – 9:15	Introduction (Chair)
9:15 – 10:15	Presentation and review of fishery and biological information, and update of the abundance indices
10:15 – 10:30	Break
10:30 – 12:00	Presentation of assessment model and projections to evaluate consequences of different harvest strategies
12:00 – 1:00	Lunch (not provided – cafeteria on site)
1:00 - 3:00	Review of Science Advisory Report (SAR)
3:00 – 3:15	Break
3:15 – 4:30	Review of Science Advisory Report (SAR)

9 December 2014 - Tuesday

9:00 – 10:15	Review of Science Advisory Report (SAR)
10:15 – 10:30	Close and Adjournment (Chair)

Working Papers

Data Review and Assessment Model Update: 2014 Framework Review of the Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc).

Bycatch of non-targeted species in the Scotian Shelf and Southern Grand Banks (NAFO 3NOPs4VWX5Z) Atlantic Halibut Longline Fishery.

Scotian Shelf and Southern Grand Banks (NAFO 3NOPs4VWX5Z) Atlantic Halibut 2014 Framework Models: Statistical Catch-at-Length (SCAL), State-Space Production (PMOD) Model (Sean Cox), and a Multi-fleet Length-based Model (HAL) for forecasting.